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ABSTRACT

One of four reports designed to assess the current state of new technologies, the document reviews the status of microcomputers in regular and special education now and for the next five years. Briefly discussed are components, software, and prices of microcomputers. Next addressed are general educational usage for instructional and administrative purposes within the past 15 years, sales trends of manufacturers, and needs local education agencies (LEAs) should consider when adopting a microcomputer system. The difference between Computer Assisted Instruction (CAI) and Computer Managed Instruction (CMI) in special education (SE) is explained, followed by discussion of the cost/benefit of these applications for classroom and administrative functions. Discussed also are software trends for CAI (such as increase of interest by medium-sized publishers in adapting regular education courseware for SE) and for CMI (such as availability of 30 systems with five components including "procedural safeguards tracking") as well as computer support applications. Among the factors described as affecting the use of microcomputers are advances in hardware technology, increased development in software, and identification of LEA needs such as staff training in specific applications. A short summary synthesizes the content and makes projections including the estimate that by 1985, 500,000 microcomputers will be used at the LEA level as contrasted with 150,000 microcomputers in the public schools in 1982. (MC)

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MICROCOMPUTERS IN SPECIAL EDUCATION

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Preface

This document is one of four reports designed to assess the current state of new technologies, review the current uses of the technologies in regular and special education, and project the manner in which these technologies will affect special education during the next five years. These reports address four very important categories of new technology: microcomputers, telecommunications, videodiscs, and communication aids.

The information presented in this report is the result of the distillation of a great deal of data from a wide variety of information sources. Foremost among these sources were:

- discussions with high-level officials from more than 60 firms which develop, produce, publish, or distribute technology hardware and software;
- responses of nearly 200 high-level LEA special education officials who attended four project technology workshops;
- information reported by such education and industry organizations as TALMIS, Knowledge Industry Publications, the National Audio Visual Association (Materials Council), the National Association of State Directors of Special Education, the TRACE Center, and the Society for Applied Learning Technology;
- Federal reports sponsored by the National Science Foundation, the National Center for Education Statistics, the Office of Technology Assessment, ED/Division of Education Technology, and ED/Special Education Programs (SEP); and
- independent research studies and surveys.

In addition to these project sources, Education TURNKEY Systems staff has conducted workshops on technology applications in special eduction for more than 4,500 state and local special education administrators.

The trends, estimates, and projections contained in this report have been derived from many sources and represent the best estimates of Education TURNKEY Systems and The Futures Group.

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MICROCOMPUTERS IN SPECIAL EDUCATION

Five years ago there were virtually no microcomputers in America's public schools; today there are more than 150,000. Three years from now there will probably be more than three times that number. This document describes the technology which comprises the microcomputer (also known as the personal computer) and discusses the applications of microcomputers in regular and special education now and for the next five years.

I. THE TECHNOLOGY

A microcomputer-based education system* consists of several components. At the heart of such a system is a microcomputer. An input device, such as a keyboard, can be built into the system or attached as a peripheral device. A system usually includes a display device such as a cathode ray tube (CRT) and often includes, as peripheral devices, a printer to produce typewritten copy and data storage devices (e.g., disc drives). Smaller microcomputers, without peripheral equipment and with moderate (e.g., 16K or 16 kilobytes) random access memory cost less than $500. A larger microcomputer with more memory (e.g., 48K) costs between $1,000 and $1,500. Complete microcomputer systems with expanded memory capacity and the addition of disc drives now cost about $3,500. Microcomputer systems with 48K of memory, two disc drives, a medium-priced printer, and a display device cost between $2,000 and $3,000.

To operate, a microcomputer system requires two types of software. Each hardware system incorporates its own software operating system -- the machine's operating language. The second type of software is application software which directs the computer in the completion of specified tasks (e.g., administrative, instructional, word processing). Operating system software is included with the microcomputer when it is purchased; application software is usually purchased separately.

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*Does not include such single-purpose hardware/software as the "Speak and Spell" spelling device and the "Versator" teaching machine. There are more than 100,000 of these devices in the schools.

From an historical perspective, today's computers are 10,000 times faster, with 16 times the memory capacity for approximately 1/200th of the cost of the computers of the 1940s. Overall, the cost-effectiveness of computing has increased more than a million fold since the 1940s with the effective-to-cost ratio doubling every two years. The technology contributing to this phenomenon has been the large-scale integrated circuitry of semiconductors -- otherwise known as microprocessor chips.

The prices of microcomputers will not drop proportionately to the declining cost of microprocessor chips, largely because of the costs of marketing and housing equipment. According to industry sources, during the next few years the cost of personal computers (with minimal peripheral equipment) typically used in the home is expected to drop from about $500 to a plateau range of about $200 to $250; the personal computer used in many schools will drop from approximately $1,000-$1,200 to about $400-$500; and the small business computer, presently selling at about $3,000, will probably drop to about the $1,500-$2,000 level.

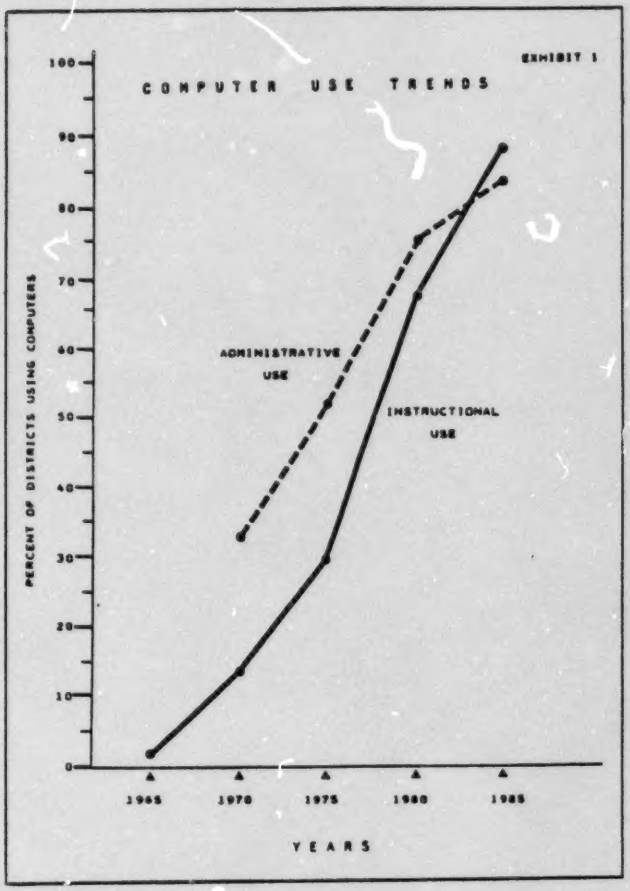
A significant shift is also occurring in the market shares of the major microcomputer manufacturers. In 1981, Apple and Tandy Corporation (Radio Shack) held more than 50 percent of the total market, with IBM holding just two percent. It is projected that by the end of 1984, IBM will surpass Apple as the industry leader, selling about 20 percent of the total microcomputer units. The combined market shares of Apple and Radio Shack will be about 30 percent.

II. GENERAL EDUCATION USE

Fewer than 1,000 microcomputers were produced in 1975 (by five firms) as compared with approximately 3,000,000 units in 1981 (by over 120 firms). About 80,000 to 100,000 units were in the public schools in 1981 and projections for 1985 range between 400,000 and 550,000.

As displayed in Exhibit 1, computer usage -- for both instructional and administrative purposes -- in public education has increased dramatically in the last 15 years. While computers were used predominantly for administrative

purposes (e.g., financial reporting, student accounting) during the 1970s, they have been increasingly used for both instructional and administrative purposes. Instructional usage of computers, particularly microcomputers, is now surpassing administrative usage. In the early 1970s, computers used for instructional purposes were found mostly in math and science courses; however, use in computer-related courses, such as programming and computer literacy, increased dramatically during the latter part of the 1970s. For students with computer access, the highest level of instructional activity remains in math and science courses.



Two recent studies, conducted by the National Center for Education Statistics and Market Data Retrieval, estimated in 1981 that 42 percent of the nation's school districts had access to one or more microcomputers (see Exhibit 2), including a surprisingly large number of small districts. Where microcomputers exist within a district, they are used by and large at the secondary level, although by 1982 the percent of elementary schools with

EXHIBIT 2

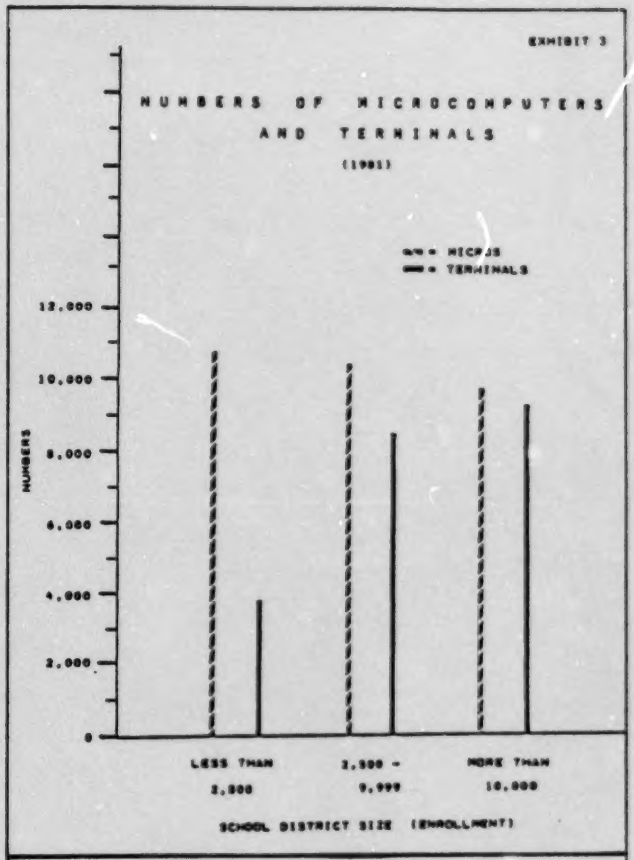
MICROCOMPUTERS
(BY DISTRICT SIZE)
(1981)

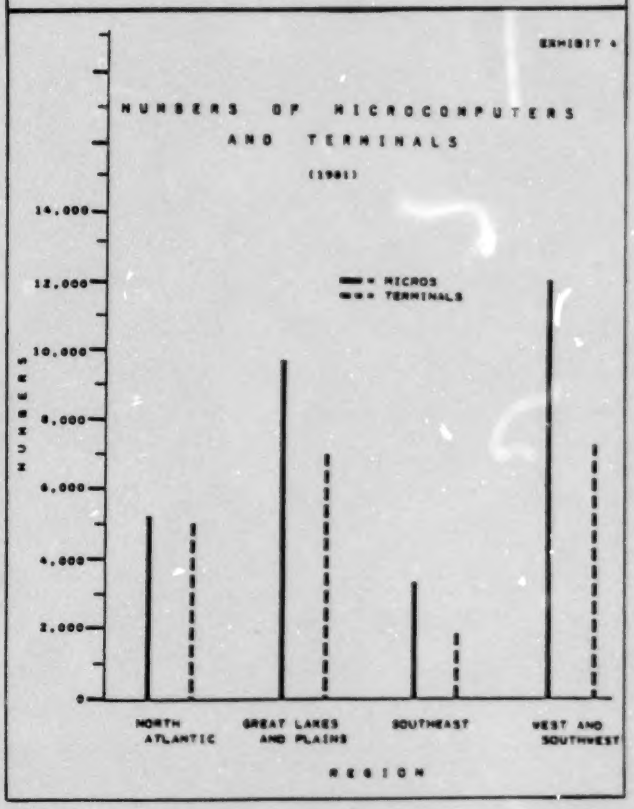
ENROLLMENT RANGE	PERCENT WITH MICROCOMPUTERS
LESS THAN 2,500	38%
2,500 TO 10,000	59%
MORE THAN 10,000	71%
TOTAL	42%

microcomputers increased to 20 percent.

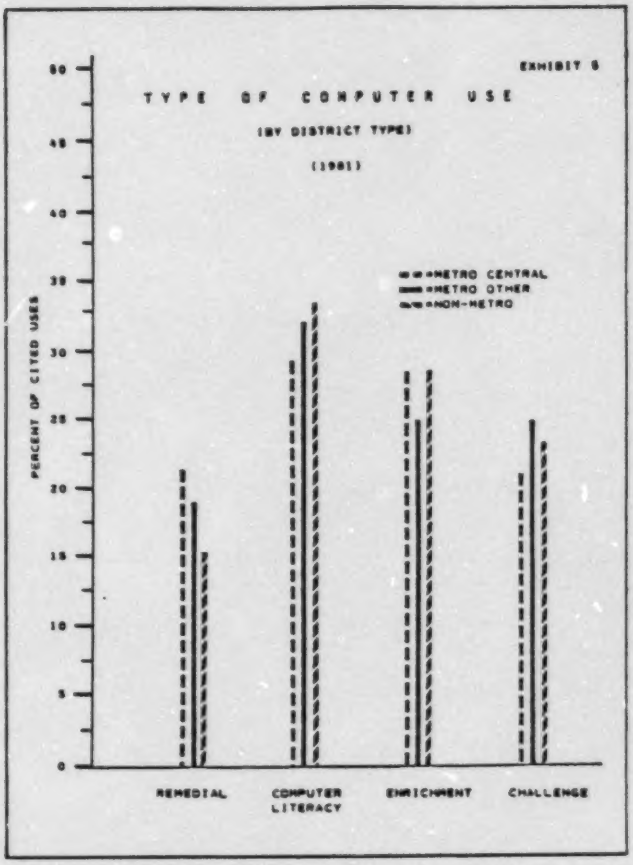
Availability and use of microcomputers is highly correlated with school size, region of the country, and demography. As illustrated in Exhibits 3, 4, and 5, respectively: smaller districts have about two and one-half times as many microcomputers as terminals (input/output devices connected to large computers); microcomputers are more prevalent than terminals in the Great Plains and the West and Southwest than in other parts of the country; and microcomputers are most likely to be used for remedial purposes in central metropolitan areas, but for computer literacy purposes in non-metropolitan areas. Patterns of usage by region of the country are shown to be relatively similar except for the Southeast, in which microcomputers are used less for remedial and more for challenge-type programs, perhaps a reflection of a greater emphasis on gifted and talented programs.

The sales of software for various applications in public schools was estimated to be $10 million in 1980-81 and $28 million





by 1981-82. Projections for 1984-85 run as high as $100 million. The typical price of a courseware package is between $20 and $40. Market analysts estimate that the average investment necessary to develop a successful software package is approximately $15,000 to $25,000.



A review of three major publishers' 1981 software catalogues indicated that approximately 35 percent of titles focus on math, 25 percent on reading and language arts, 15 percent on science, and five percent on computer literacy. An industry report on 1982 software sales estimated that courseware products for math and language arts constitute 47 percent and 43 percent, respectively, of the total, with most courseware designed for the K-6 and 9-12 grade levels and approximately 30 percent classified as basic curricula as opposed to supplemental materials. The majority of courseware offerings were designed for drill/practice and tutorial instructional modes, rather than simulation and problem solving.

A survey conducted in 1982 by Electronic Learning reported that at the building level approximately 88 percent of the microcomputers at the school level were used for instructional purposes, 35 percent for administrative purposes, with about 23 percent used for both purposes. Most administrative software packages are modular in nature. Over half are either authoring systems used by teachers and others in developing curriculum; curriclum management packages which can be used for diagnosis, prescription, and instructional management purposes or packages for building and district-level administrators (e.g., scheduling, payroll, attendance). The cost of developing

multipurpose administrative software is approximately six times greater than for instructional packages.

Until recently, the market shares of microcomputer hardware in public schools have been rather stable. The three manufacturers -- Apple, Radio Shack, and PET -- which entered the education market first are expected to maintain the large market shares for the next year, although market analysts estimate that later entrants -- Atari, Texas Instruments, Digital Equipment, and IBM -- will increase their market shares over time. Between 60 and 80 percent of the courseware products available in 1982 were designed for use on the Apple, with the remainder designed for Radio Shack, Commodore PET, Atari, and Texas Instruments equipment, in that order.

During 1980-81, it was estimated that up to 90 percent of all of educational courseware was developed by small- or medium-sized developers some of which are also publishers (e.g., ERI, Intentional Educations, DLM, Hartley). In 1982 an industry report estimated that, of the 25 largest developers of educational courseware, approximately 30 percent were traditional education publishers, 20 percent were small specialized developers/publishers, 20 percent were small software houses, 15 percent were hardware vendors with courseware publishing divisions, and the remainder were other groups, including nonprofit organizations.

A major bottleneck in courseware development remains the limited number of talented teams with the necessary experience and expertise to develop quality courseware. For the most part, this talent remains in small- or medium-sized firms rather than the large traditional education publishers which are cautious about hiring in-house development teams. Milliken Publishing, which develops and markets courseware for several brands of hardware, has the largest market share in microcomputer math courseware sales. However, sales of recent entrants such as Scholastic, SFN, The Learning Company, and others are expected to increase in the next few years. In addition, several companies have converted their minicomputer or mainframe courseware (e.g., CCC, CDC/PLATO) to the types of microcomputers most often found in the schools.

Development/distribution strategies vary considerably among the hardware vendors and education distributors. For example, in 1978 Apple entered into an arrangement (since terminated) with Bell & Howell (a large education audiovisual distributor) to sell Apple computers under the Bell & Howell name. Apple also sells microcomputers to schools through retail computer stores. Radio Shack has entered into some arrangements with publishers, but for the most part sells microcomputers and software to schools either directly or through its retail outlets. Some of the national education distributors market courseware directly, others use existing dealer distribution networks, and others use a combination of approaches. In 1982, TALMIS estimated that about 40 percent of courseware sales to public schools were through retail outlets; only 13 percent were from traditional school suppliers and audiovisual dealers. This pattern is expected to reverse in the next three years as traditional dealers develop their microcomputer marketing capabilities.

A number of perceived needs exist for LEAs as they begin to adopt microcomputer educational systems:

- orientation and computer literacy training, including opportunities for "hands on" demonstrations;
- assistance in reviewing and selecting courseware, including specific information on alternative packages;
- a wider range of quality courseware;
- assistance in planning, particularly identifying user needs and technology alternatives which meet these needs;
- staff development and training on the use of specific technologies, including "freed up time" to participate actively in training;
- modifications in existing LEA procedures for purchasing and using technology (scheduling, security, equipment control);
- software publishers' unwillingness to allow LEA preview of software; and
- lack of funds for purchasing hardware and courseware.

Developers and publishers have identified similar problems, including:

- the inability of many LEAs to specify their needs or to use appropriate criteria in selecting software and hardware;
- the lack of trained LEA staff;
- inadequate protection against unauthorized duplication of courseware which discourages private investment in costly courseware development and marketing; and
- high cost of marketing caused by expensive demonstrations and the time-consuming decision-making process on the part of LEAs and existing inadequacies in firm's marketing networks.

III. SPECIAL EDUCATION USE

There are two basic categories of microcomputer applications for special education:

- Instructional: Computer-Assisted Instruction (CAI) which encompasses various subject matters and usages (e.g., drill, practice, tutorial) in which students interact directly with the microcomputer.
- Administrative/Support: Computer-Managed Instruction (CMI) -- which includes a variety of applications ranging from diagnosis/prescription, instructional management, student progress monitoring, tracking related to procedural safeguards, and other activities designed for the most part to aid the teacher or special education staff -- and Computer Support Activities (CSA) -- which includes a variety of administrative applications such as test scoring and analysis, report writing and generation, evaluation, and statistical analysis.

While some overlaps exist, these categories differ in important ways. The primary beneficiaries vary. CAI, for example, is designed to benefit the student directly and to assist the teacher indirectly, while CMI and CSA applications hold direct benefit for instructional or administrative staff and help students only indirectly. The stage of development and availability of these applications varies. For example, few CAI programs have been designed specifically for special education populations; in the short term, most CAI applications will have to be adapted from regular education courseware. On the other hand, virtually all of the existing CMI applications, including IEP

generators, etc., have been designed specifically for special education, in some cases by LEAs. The groups who are developing and marketing software for the application categories also differ considerably along several dimensions including size and nature of distribution.

A. BENEFITS

Microcomputer applications offer potential benefits for special education users -- students, teachers, and administrators -- though the nature, timing, and extent of the potential benefits will vary.

1. Instructional Applications

Few, if any, studies have yet been conducted of the cost-effectiveness of microcomputer-based instructional systems. However, earlier studies of CAI on minicomputer or mainframe systems suggest some potential benefits; an analysis of teachers' perceived needs provides further insights.

Two major summary analyses of CAI effectiveness studies were conducted by Bork and Chambers (1980) and Kulick (1980, 1982). They found that the use of computer-assisted learning improved learning or showed no differences when compared to traditional classroom approaches; reduced time up to 30 percent, when compared to regular classroom instruction; and improved student attitudes toward the use of computers in the learning situation. From these findings, one might infer several advantages of microcomputer-based CAI for special education populations, including reduced student frustration levels, increased reinforcement and motivation, low-cost repetitious presentations of materials, and increased flexibility for adaptation to specific learner needs and styles.

Further insights are provided in the National Needs Assessment Study (ETS, 1980). More than 88 percent of all 30,000 special education teachers surveyed in 1978 indicated a substantial need for new or improved media and materials. Perceived curriculum needs for new media included social behavior, reading, word attack skills, and social self-acceptance. Similarly, perceived new media format needs included manipulative games, toys, and puzzles;

programmed instruction/individualized instruction; drill and practice; repetition/reinforcement; alternative learning strategies; and versatility in dealing with different handicapping conditions. Quality courseware which uses the full capabilities of advancing hardware technology can meet these perceived needs. During the SpEd Tech workshops, most special education decision makers responded confidently that microcomputers would be used within the next year in their special education instructional programs.

2. Administrative Applications

At the classroom, school, and district levels, instructional management and administrative applications of microcomputers offer potential benefits in a number of areas, including:

- reduction of time-consuming routinizing activities and a decrease in paper work associated with Federal and state mandates;
- improved decision making through timely reporting of accurate and reliable data;
- more efficient record keeping, particularly on procedural safeguards, which could improve communication with parents and minimize legal and other costs; and
- increased user control through stand-alone microcomputers and less dependence on centralized or regional data processing facilities.

Indeed, a 1982 survey by the Council for Administrators of Special Education (CASE) reported that the perceived advantages of computerized management systems in special education were efficiency, control, accessibility, accuracy, speed, and flexibility.

Most of the benefits have cost-saving implications, the magnitude of which can be inferred from the recent Rand Study of the "Cost of Special Education" (1982). Relying upon data collected for the 1977-78 school year, this study estimated the cost of special education by various types of resources used and by handicapping categories. Administrative or overhead costs for handicapped students are approximately $500 versus about $200 for nonhandicapped students.

In addition, staff time devoted to developing/updating IEPs and conducting assessments for handicapped students consumes an additional $200 to $300. If the use of a microcomputer application addressing the above functions could achieve a 25 percent reduction in staff time, a system costing $6,000 could pay for itself in one year if it were used with about 40 special education students or, alternately, could transfer administrative time to student contact time.

In addition to administrative time and cost savings, CMI systems offer great potential for improving the individual teacher's capacity to individualize instruction and manage/monitor individual student's learning activities, especially in "mainstream" type settings. Indeed, the National Needs Assessment reported high teacher perceived needs for improved monitoring and evaluating of student progress. Microcomputer instructional management applications, which allow LEAs to incorporate their own learning objectives, mastery of items, and referenced learning activities, have increased dramatically during the last two years in both regular and special education.

A variety of microcomputer-based support applications have also surfaced in public schools in the last three years. Many of these applications can be used directly by special education administrative staff; in other instances, minor adaptation may be required. Approximately half of the SpEd Tech workshop participants indicated that they presently had access to word processing equipment, most of which are microprocessor-based. In addition, participants from larger districts, which use a large number of tests for special education students, felt strongly that microcomputers could be used for test scoring and analysis purposes. If a district with 3,000 students were paying a service bureau or test manufacturer $2 per pupil to score both pre- and post-tests, a total hardware/software system could pay for itself in one year and only be used for that purpose for ten to 20 days.

B. SOFTWARE TRENDS

The estimated number of microcomputers currently in use and projected for 1985 are presented in Exhibit 6. These estimates are based upon discussions with developers/publishers, industry reports, and a Trend Impact Analysis conducted for this project.

EXHIBIT 6

PROJECTED NUMBER OF MICROCOMPUTERS

(1,000s)

	PRIMARY USE			
	INSTRUCTIONAL		ADMINISTRATIVE	
	1982	1985	1982	1985
REGULAR EDUCATION	100	280	25	70
SPECIAL EDUCATION	13	125	10	25
TOTAL	113	405	35	95

1. Instructional Applications

Very little CAI software (courseware) has been designed specifically for special education populations. Of the 1,200 courseware titles offered in the catalogues of the major courseware publishers in December 1981, fewer than ten were designed specifically for special education. While the number of special education courseware packages has increased in the last year, the percentage of special education courseware relative to the total number of packages available through publishers and developers remains low. Of the total number of microcomputers used in special education, a larger percentage are used primarily for instructional rather than administrative purposes (approximately 60 percent versus 40 percent). Although commercial courseware offerings are limited, several inferences can be drawn: (a) the sales volume of developers/publishers who have designed special education software are relatively high; (b) special education teachers and staff are adapting, to varying degrees, courseware designed for regular education to meet the needs of special education populations; and (c) courseware is being developed by small- to medium-sized developers or LEA staff for use primarily as a supplement to existing special education materials.

Interviews with developers/publishers indicate that more than 90 percent of the commercially available courseware for special education is being produced and marketed by fewer than ten publishers, all small- or medium-sized

(e.g., DLM, Borg-Warner Education Systems, Hartley). The large traditional education publishers have not entered into the special education market to any substantial degree, nor are many likely to in the immediate future. Large traditional education publishers feel that special education markets are too thin and involve too high costs to obtain a reasonable rate of return on their courseware development and marketing efforts. They feel that LEA decision making in special education is often fragmented, requiring time consuming "demonstrations", that their existing dealer networks are not efficiently familiar with the jargon of special education and cannot be motivateed to market to such narrow markets. On the other hand, between 30 and 40 percent of the medium or large education publishers have expressed some interest in allowing LEAs to adapt portions of their courseware or otherwise working with LEAs in the adaptation process to meet special education needs. Others, however, are hesitant to allow anyone to modify existing core curriculum or supplemental CAI packages because of their copyright and security policies and the lack of staff time.

Most of the CAI courseware presently used for special education populations is designed for elementary or low academic entry level skills and focus upon content areas such as mathematics and language arts. Secondary level courseware, for the most part, focuses upon survival skills (e.g., money management) and social acceptance. A survey conducted in March 1983 at the Council for Exceptional Children's Microcomputer Conference indicated that LEA special education staff considered priority courseware areas to be reading and language arts, computer litercy, social skills, and survival skills. The demand for mathematics courseware was quite low, perhaps indicating that a satisfactory base of software already exists in that content area.

While CAI courseware is not as prevalent in special education as in regular education, there are a number of reasons for expecting the use of CAI in special education to increase significantly over the next three years.

While Federal and some state funding cutbacks have been experienced for other "categorical programs", such cuts have not been as severe in special

education. Indeed, a recent NAVA report projected an increase from $367 million to $650 million in expenditures for special education instructional materials and equipment between 1982 and 1985. The Rand Corporation's Cost of Special Education Study (1982) found that instructional materials and equipment expenditures for handicapped children are approximately 60 percent greater than for nonhandicapped children (see Exhibit 7). Undoubtedly, many courseware developers and publishers will be enticed to enter the special education market over time.

EXHIBIT 7

COST COMPARISON

NONHANDICAPPED VERSUS HANDICAPPED
ADMINISTRATIVE/NONPERSONNEL
INSTRUCTION

	NONHANDICAPPED	HANDICAPPED
INSTRUCTIONAL SUPPLIES/TEXTS	$34	$55
INSTRUCTIONAL EQUIPMENT	14	21
RELATED SERVICES/EQUIPMENT	3	17
RELATED SERVICES/ADMINISTRATION*	5	$7**
DISTRICT LEVEL ADMINISTRATION	105	200
SCHOOL LEVEL ADMINISTRATION	96	209
FACILITY MAINTENANCE/OPERATION	207	370
FACILITY MODIFICATION	26	12
DEBT SERVICE	147	248

* COST OF ADMINISTERING RELATED SERVICES
** COST OF ADMINISTERING SPECIAL EDUCATION SERVICES

A small but significant number of medium-sized publishers/distributors are showing increasing interest in adapting regular education courseware through the development of supplemental CAI programs to meet special education needs Much of this adaptation has been encouraged and supported by SEP.

SEP has undertaken additional initiatives to facilitate the development/distribution of software-related products for special education including: (a) a contract with LINC Resources to develop procedures for identifying teacher made/locally developed products (including courseware) for potential distribution; (b) a contract with Education TURNKEY Systems to refine procedures of the existing Market Linkage Project for Special Education (MLPSE) to accommodate the distribution of microcomputer software products; and (c) several projects designed to provide technology technical assistance and dissemination to special education staff.

As adaptive devices (e.g., light pens, voice synthesis, voice input) become increasingly available and costs decrease (probably as a result of these devices being used in industry as job aids for handicapped employees), opportunities for handicapped students to have access to CAI programs on commercially available hardware will increase dramatically. In some instances, LEAs will be under pressure to provide reasonable accommodation under Section 504 to allow mainstreamed handicapped students to have equal access to microcomputer programs available for regular education populations. In the last year many courseware publishers have incorporated voice input or voice output into their software products for both the home and education markets.

As authoring systems become available at lower costs and as LEA staff increasingly use these systems, opportunities for the development of CAI supplemental programs will increase the availability of courseware.

2. Administrative Applications

As indicated above, there are two generic types of administrative applications in special education -- Computer-Managed Instruction and Computer Support Applications.

a. Computer-Managed Instruction (CMI)

The first microcomputer-based CMI systems designed for special education were developed and field-tested in 1978 and 1979. Approximately ten CMI systems which had one or more of the components described below were operational on large mainframes or minicomputers. In approximately half of those cases attempts were made to modularize the software packages for use on stand-alone microcomputers or microcomputers tied into larger units.

At the present time, more than 30 CMI systems on at least five different microcomputer types of hardware exist or are being developed for use in school settings. Most of these CMI systems have most, if not all, of the following general components:

- Student Demographic File Structure: contains student information required by P.L. 94-142 and state special education laws; used for reporting purposes and, in some systems, for simple statistical analyses.

- Procedural Safeguards Tracking: contains procedural safeguards information; allows for the documentation of individual steps followed in processing a child into and through special education programs.

- Test Data: includes each child's testing history and test score displays.

- IEP Management: incorporates identification of overall education needs, long-term goals, and, in some cases, short-term objectives and instructional activities; may also include mastery-level criteria and dates when mastery is achieved.

- Student Monitoring: monitors individual student progress against either long-term objectives or short-term objectives.

In addition to CMI systems which have been designed specifically for special education, several general microcomputer management systems are being adapted for use in special education. Most of the adaptation involves format changes and expanded file structures to meet specific state and LEA requirements for IEPs. While modified CMI systems have been developed by publishers, either in-house or under contract, virtually all CMI systems designed specifically for special education have been developed by small custom software developers or by LEA (or intermediate unit) special education staff.

It is estimated that by 1985 more than 100 CMI systems designed or adapted for special education will be used in public schools. Most of these will be available directly from developers or through specialized dealers and representatives. A number of factors will influence the rate of adoption and use of CMI applications.

The availability and use of CMI applications can be attributed to specific mandates and processing requirements found in P.L. 94-142 and state statutes; most LEA workshop participants, however, felt the need for these types of applications, regardless of legal requirements. Indeed, approximately half of the SpEd Tech workshop participants felt that these applications would continue to be adopted even if Federal and state requirements were significantly reduced.

A reduction in marketing costs will result in lower prices for these systems and, thus, increase their use. Virtually all CMI developers currently use costly direct marketing strategies; over time, specialized dealers and representatives will emerge as lower cost marketing alternatives.

The emergence of user-friendly, self-customizing administrative applications will have a significant impact on the rate of adoption and use of CMI. Special education administrators, in general, feel that "canned" administrative packages do not meet their specific needs. One response on the part of several developers has been the design of modular packages which provide consumer choice; another has been the costly customization of generalizable packages to meet specific LEA needs. During the next few years, the number of LEAs developing their own CMI software through the use of program generators and data base management systems will increase, as will the number of self-customizing modular packages.

Technology advances and reduced costs in telecommunications and hard disk technology will facilitate the use of networking on a district-wide or even state-wide basis. Two states are presently developing state-wide special education reporting systems which are totally microcomputer-based.

b. Computer Support Applications (CSA)

The CASE survey of special education administrators indicated that about 30 percent of the administrative packages in use are integrated multipurpose systems and 70 percent are specialized single-purpose packages. It is likely that more and more packages will become multipurpose during the next five years. The survey identified the current administrative applications of microcomputers in descending order of prevalence: student enrollment, student tracking, student monitoring, financial control, word processing, personnel record keeping, test scoring and analysis, and inventory control. Virtually all computer support applications used in special education have been designed for general education or government/industry use and require only minor modification and adaptation for use in special education.

Word processing is used for communications with parents, internal LEA correspondence, and simple report generation. For the most part, special education administrators use commercially available word processing equipment; surprisingly, most workshop participants were unaware of low-cost, high quality commercially available word processing packages which can be used on microcomputers.

Approximately 20 test scoring and analysis applications are presently available and used, to varying degrees, in special education. About half of these applications are part of multipurpose CMI packages, while the remainder are stand-alone single application products. One commonly used package scores and analyzes test results from the Woodcock-Johnson test; several packages generate tests to orient special education students to state minimal competency requirements. A large number of LEAs are presently using a test scoring package with mark sense card scanners (e.g., the Chatsworth MR-500). In addition to test scoring, these latter devices are being used extensively by LEAs for other data entry purposes (e.g., attendance).

During the next few years, significant use of microcomputer support applications can be expected to: (1) assist in the scheduling and control of instructional equipment, including microcomputers; (2) provide diagnostic services for maintaining and servicing microcomputer hardware; (3) schedule special education students and staff, particularly itinerant teachers; (4) conduct evaluations of special education programs; and (5) file and access large data bases.

As special education staff become more knowledgeable about and develop expertise in the use of microcomputers, creative support applications will be identified, developed, and used. The emergence of program generators and Visicalc-type applications will provide increased opportunities for key staff, with minimal computing skills, to use the technology. As reliability increases and costs decrease for adaptive devices, additional opportunities will be created for alternative data entry techniques, further increasing opportunities for support and administrative applications.

IV. FACTORS AFFECTING USE

A number of major factors and activities will affect the use of microcomputer-based applications for special education during the next few years. Key influential factors include advances in hardware technology, software development, improved commercial marketing and distribution, and enhanced LEA capabilities.

A. ADVANCES IN HARDWARE TECHNOLOGY

The ratio of microcomputer effectiveness (i.e., speed and capacity) to cost can be expected to continue doubling over the next few years as it has the last decade. While the cost of hardware will plateau, greater speed and capacity will continue to provide opportunities for more instructional and administrative applications in special education. In addition, specific technology breakthroughs or advances in the following areas will have significant impact over the next three years:

- Availability of Emulators: The development and increased use of these interface devices will reduce problems of compatibility, allowing interaction between different types of hardware. These devices may also allow the conversion of software applications and data bases from one microcomputer to another, thus increasing the availability of courseware and reducing the cost of switching from mainframe to microcomputer systems.

- Low-Cost Reliable Interface Devices: These devices will increase the cost-effectiveness of interactive microcomputer systems and enhance the accessibility of handicapped students and staff to microcomputers.

- Increased Reliability and Lower Cost for Peripheral Equipment: The reliability of peripheral equipment will improve and the cost will be reduced. If copyright issues are resolved, advances in hard disk technology and software interfaces will increase opportunities for low-cost networking.

B. DEVELOPMENTS IN SOFTWARE

The limited availability of quality special education software is a major bottleneck. However, during the next few years, the availability of a wider

range of quality courseware can be expected. Small- to medium-sized developers/publishers will increasingly see the potential market for courseware products in special education and will either increase privately-funded development efforts or adapt existing courseware for special education applications. Recent initiatives undertaken by ED/SEP to adapt courseware products will not only facilitate the adaptation process but also serve as a general catalyst for privately supported development/adaptation. Other developments which will increase the availability of courseware are:

- Expanded Use of Authoring Systems: A number of authoring systems are presently being used by developers of courseware products. Over time some LEAs can be expected to use authoring systems to develop their own supplemental courseware in subject areas for which commercial courseware is not presently available. While the quality of resultant courseware will vary considerably, the use of authoring systems should partially fill a substantial need.

- Development and Use of Program Generators: In the next few years, several program generators are expected to be available to assist administrators with no programming skills to develop self-customized data base management and administrative applications for special education. As the cost of program generators decreases and LEA skills to use them increase, demand for canned administrative packages is likely to decrease significantly.

- Reduced Unauthorized Copying of Software: A major deterrent to private sector investment in costly courseware development is the lack of protection against unauthorized copying and use of software. Several factors will reduce the extent of this problem, including: (a) adoption of policies by LEAs to prevent unauthorized use; (b) court decisions supporting developer's interests; (c) revised publisher/developer policies to allow LEAs to adapt/modify courseware for special education; (d) general recognition by LEAs that the paucity of quality courseware is related to the misuse of developer products; and (e) the availability of lower cost software.

C. IMPROVED MARKETING/DISTRIBUTION

Developers and publishers of courseware use a variety of marketing/distribution strategies. Traditional audiovisual education dealers have not marketed courseware and courseware-related products effectively. As a result, the number of specialized, high technology courseware dealers will continue to grow; these specialized dealerships will play a critical role in

the adoption and use of instructional courseware. These dealers can also be expected to take an increasing interest in marketing administrative applications, especially those developed by small firms which now market their packages directly. Other activities and developments that will improve the cost-effectiveness of software marketing/distribution for special education include: (a) the increased use of electronic mail/bulletin board systems, which allow publishers/developers to interact directly with developers and users and to "down load" courseware demonstrations; and (b) refinements in the ED/SEP-supported Market Linkage Project for Special Education, designed to facilitate linkage between software developers and commercial distributors.

D. ADDRESSING LEA NEEDS

The degree to which perceived needs of LEAs can be met will greatly influence the adoption and effective use of microcomputer applications in special education. Based upon the information collected during the project, particularly during the regional workshops, a number of perceived needs/problems were identified.

- Technology Orientation/Computer Literacy: The need for general computer literacy and orientation has been identified in virtually all SEP-funded projects as a major precondition for the effective adoption and use of technology. Orientation and training is now being provided by SEAs, commercial publishers, consultants, microcomputer user groups, and other national or state-wide resources. While, in 1980, only three major teacher training institutions had courses related to computer use in education, a recent survey by Classroom Computer News found that approximately ten percent of such colleges now have at least one literacy or orientation course. Thus, while the demand is great, it is beginning to be met by various means.

- Staff Training in Specific Applications: While computer literacy and orientation needs are, to a large degree, being met, specific training needs for the selection, installation, and use of specific microcomputer applications are not. Few LEA personnel are skilled in this area and they are difficult to retain; release time for training purposes is often not available. Few developers, publishers, or dealers have the necessary time and/or skills to conduct effective training, particularly with respect to administrative applications. The opportunity for using technology (e.g., telecommunications) to assist in applications-specific training is increasingly being recognized as a feasible alternative by publishers/developers. While a

lack of application-oriented training may not impede the purchase of microcomputer hardware and software, it can seriously limit the effectiveness of its use. The lack of skilled LEA personel was perceived to be the major barrier to the effective use of microcomputer applications by developers and publishers.

- Planning: The types of planning needs identified by LEAs include: (a) identifying those needs which technology can meet appropriately; (b) specifying detailed school- and district-level needs; and (c) selecting software. In some states these needs are being met through SEA guidelines and checklists, and most states have begun to take a leadership role in providing planning workshops. By and large, however, many needs of a planning nature remain unmet. While LEAs may purchase hardware and software, few are using microcomputer-based applications in a systematic and effective manner or are fully realizing their potential benefits.

- Modification of LEA Policies and Procedures: Effective adoption and use of microcomputer-based applications in many LEAs will require changes in purchasing methods, hardware inventory and control, software security, and equipment scheduling. Some LEAs will begin to use total package procurements (i.e., hardware, software, training, maintenance, and support included) for administrative applications. LEAs will have to change and/or create policies to prevent staff from violating copyright, license, and other agreements regardng unauthorized use and duplication of courseware. In order to reap the benefits of technology, LEAs will have to modify existing procedures for: (a) scheduling, to allow students to achieve at their own rates; (b) classroom organization, to allow for individually paced instruction and alternative learning paths; and (c) integration of microcomputer-based administrative applications into existing district-wide procedures and reporting systems.

V. SUMMARY

Microcomputers are becoming more and more commonplace, in both private homes and public schools. Current estimates indicate that, as of 1982, about 150,000 microcomputers exist in America's public schools, with about 67 percent of the nation's school districts having at least one. By 1985, it is expected that about 500,000 microcomputers will be in use at the local education level.

From an instructional standpoint, microcomputers offer potential benefits in the general improvement of special education through reduced teacher time on routinized activities, improved student attitudes, greater flexibility to serve different handicapping conditions, and higher correlations with job-related

technological skills. Instructional software is being developer principally by small- and medium-sized firms, a trend which is likely to continue for the foreseeable future. A great deal of special education courseware is, and will continue to be, adaptations of regular education materials, much of it adapted by LEA staff.

The administrative benefits of microcomputers in education (particularly special education) include reduced staff time on paper work, more timely and accurate data reporting, more efficient record keeping, and enhanced management control. Much of the administrative software has been designed specifically to address the reporting and record keeping requirements of special education. Although most existing administrative software is in the form of single-purpose packages, there is an increasing trend toward modularized, multipurpose systems.

During the next five years, considerable progress is expected in both hardware and software. The cost-effectivenss of microcomputer hardware will continue to increase geometrically, lower cost peripheral equipment will become available, and hardware compatibility will be improved. Supported by private and Federal (ED/SEP) funds, software development for special education will accelerate and greater emphasis will be placed on systems which allow nonprogrammers to create their own software. The marketing of microcomputer hardware and software to schools will, with ED/SEP support, become more efficient as education marketers develop greater technological sophistication.

In order for microcomputers to play an effective role in special education, a number of LEA needs must be met. Specifically, LEA special education staff must develop a basic computer literacy and a more detailed awareness of specific microcomputer applications. They must also develop planning procedures for the systematic implementation of microcomputers and modify existing management practices to suit the nature of this technology.